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New records of *Cuscuta* L. (Convolvulaceae) in Central-West Brazil

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Abstract

The genus *Cuscuta* L. (Convolvulaceae) are holoparasitic plants with cosmopolitan distributions, and they are usually difficult to identify. Based on several new field collections, we present three new floristic records from this genus in Central-West Brazil. *Cuscuta platyloba* Progel and *Cuscuta partita* Choisy are cited for the first time from Mato Grosso do Sul state, while *Cuscuta xanthochortos* var. *carinata* Mart., which was previously only known from southern Brazil, is also shown to be present in the Central-West region of the country. An identification key of *Cuscuta* species from Mato Grosso do Sul is also provided.

Keywords

Dodders, identification key, Mato Grosso do Sul, parasitic plants

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Introduction

Cuscuta L. is a genus of herbaceous holoparasites with approximately 217 species, which are found on every continent, except Antarctica (POWO 2020; Yuncker 1932; Stefanovic et al. 2007; Costea et al. 2015), and are popularly known in English as dodders (McRitchie 1990). In Brazil, 26 species are known to occur in all biomes and kinds of vegetation (Simão-Bianchini and Ferreira 2015; Flora do Brasil 2020). However, no concerted floristic or taxonomic studies have been conducted after Progel (1871) and Yuncker (1932). Furthermore, one new species of *Cuscuta* was recently described from Rio Grande do Sul (Ferreira et al. 2014).

Some botanists have supported this genus as a separate family, Cuscutaceae, because of its morphological reductions related to parasitism (Du Mortier 1829; Progel 1869; Roberty 1952; Dahlgren 1980; Cronquist 1988; Takhtajan 1997; Austin 1998). However, *Cuscuta* is currently included in the family Convolvulaceae based on molecular phylogenetic studies that have shown the genus is nested within the morning glories family (Stefanovic et al. 2002; Stefanovic and Olmstead 2004). Also, *Cuscuta* has strong affinities with Convolvulaceae based on their flowers (Wright et al. 2011, 2012), fruits (Ho and Costea 2018), and seeds (Olszewski et al. 2020).

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Yuncker (1932) conducted a worldwide taxonomic revision of *Cuscuta*, providing an infrageneric classification as well as descriptions and illustrations for all the species. Based on gynoecium morphology, Yuncker (1932) recognized three subgenera: *Monogyna*, *Cuscuta*, and *Grammica*. More recently, molecular, morphological, and biogeographic studies (Stefanovic et al. 2007; García et al. 2014; Costea et al. 2015) confirmed three of the subgenera (*Monogynella*, *Cuscuta* and *Grammica*) and added a fourth subgenus, *Pachystigma* to the infrageneric classification of *Cuscuta*.

Species of *Cuscuta* are often considered generalists, as they can parasitize different plant species from different families, including Convolvulaceae, and they can attach to more than one host simultaneously (Parker and Riches 1993; Costea and Tardif 2006; Meulebrouck et al. 2010; Kaiser et al. 2015). However, more recently, degrees of host specificity ranging from specialist to generalist have been reported in *Cuscuta* (García et al. 2018; Costea et al. 2020). A relatively small number of species (ca 15) are invasive/noxious weeds that can be extremely destructive in numerous crops due to the lack of efficient herbicides to control them and since their seeds remain viable in the soil for several years (Costea and Tardif 2006).

All *Cuscuta* species are morphologically adapted for parasitism and have stems that generally vary from red to yellow because of the absence of chlorophyll. The leaves are represented by tiny scales and the plant has reduced ephemeral roots (Behdanvari et al. 2015), with specialized structures called haustoria to absorb water and nutrients from hosts (Westwood et al. 2010; Furuhashi et al. 2011; Kim and Westwood 2015).

After seed germination, *Cuscuta* seedlings attach to a host since they can only survive for a short period on their own (Furuhashi et al. 2011). The green color during the seedling stage is due to the presence of chlorophyll, and indicates low photosynthetic activity, and low affinity towards CO_2 (Hibberd and Dieter Jeschke 2001). In addition, studies have also reported ephemeral and true roots from *Cuscuta* seedlings, which may exhibit arbuscular mycorrhizal fungi (Behdarvandi et al. 2015).

Despite *Cuscuta* species being more frequently reported for their negative impacts on many crops, the genus has also been suggested as a model to study plant–plant interactions (Hettenhausen et al. 2017). Furthermore, dodders present medicinal applications, mainly in traditional Chinese medicine (Ahmad et al. 2017). In popular medicine, dodders are used to treat sexual impotence, prevent senescence, and regulate the immune and endocrine systems (Donnapee et al. 2014). At least 24 species have had their secondary metabolites described in the literature (Ahmad et al. 2017; Flores-Sánchez and Garza-Ortiz, 2019). These constituents have been associated with several pharmacological activities described from various extracts, including hepatoprotective, anti-osteoporotic, antioxidant, antimicrobial, anti-aging, anti-proliferative, antidiabetic, renoprotective, and effects on the reproductive system (Donnapee et al. 2014; Ahmad et al. 2017; Flores-Sánchez and Garza-Ortiz 2019). In addition, the majority of *Cuscuta* species are numerous and act as keystone organisms in their natural ecosystems, and therefore require conservation measures as some are presumed extinct (Press and Phoenix 2005; Costea and Stefanovic 2009).

Field explorations in relation to pharmaceutical studies of plant biodiversity in Mato Grosso do Sul have revealed some new records of *Cuscuta* species in Central-West Brazil. The aim of this article is to report these new floristic findings and increase information about the flora from Mato Grosso do Sul.

Methods

Cuscuta species were collected in three localities in Mato Grosso do Sul, Brazil, and used to perform pharmaceutical studies of secondary metabolites profile in our research laboratory.

The plant materials were identified in the Laboratório de Botânica at Universidade Federal de Mato Grosso do Sul (UFMS), Jardim Botânico de Porto Alegre, Instituto de Botânica of Núcleo de Pesquisa Curadoria do Herbário and Laboratório de Sistemática Integrativa of Universidade Federal Rural de Pernambuco. A Leica EZ4 HD stereomicroscope and literature (Yuncker 1923, 1932; Flora do Brasil 2020) were used to identify material. Herbarium specimens were deposited at the Herbarium CGMS of Universidade Federal de Mato Grosso do Sul and duplicates were sent to the Herbarium Alarich R.H. Schultz (HAS) of Museu de Ciências Naturais (MCN) of Secretaria do Meio Ambiente e Infraestrutura do Rio Grande do Sul (acronyms according to Thiers (2020).

Results

The new records reported here expand the distribution of three *Cuscuta* species in Brazil: *Cuscuta platyloba*, *Cuscuta partita*, and *Cuscuta xanthochortos* var. *cari-nata*. Figure 1 presents the geographical distributions of these species in Brazil and highlights the new records from Mato Grosso do Sul. These species are native to Brazil but are reported here for the first time from Mato Grosso do Sul.

Cuscuta partita Choisy

Figure 2

New records. BRAZIL • 1 specimen; Mato Grosso do Sul, Aquidauana, Piraputanga, Furnas dos Baianos, on the top of the hill; 20°27′12″S, 055°33’22»W, 362 m a.s.l.; 21 May 2018; fl. fr.; C. M. Costa leg. (CGMS 75473) • 1 specimen; same locality; 10 Dec. 2018; fl. fr.; C. M. Costa leg. (CGMS 75480, HAS 94417).

Identification. Flowers ca 2–3 mm long, reddish at anthesis; calyx as long as the corolla tube, lobes ovate to lanceolate, acute to acuminate at apex, not overlapping; corolla urceolate, lobes triangular, acute or acuminate at

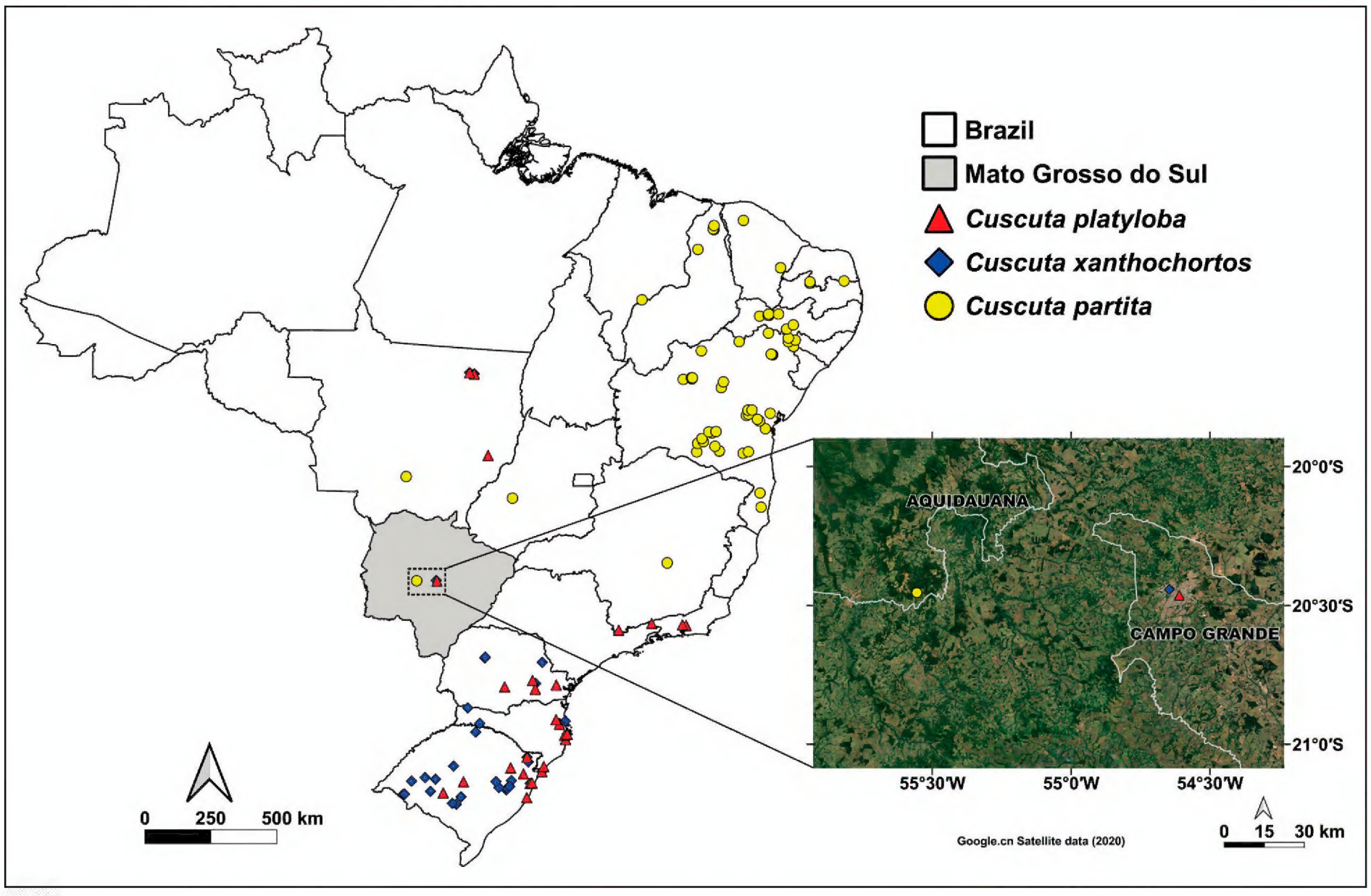

Figure 1. Geographical distribution map of *Cuscuta* species (*C. platyloba*, *C. xanthochortos*, and *C. partita*) in Brazil. The new occurrence points are indicated within the dashed quadrate.

apex; infrastaminal scales shorter than the corolla tube, fringed with moderate processes; capsule circumscissile.

Geographic distribution. *Cuscuta partita* occurs in the West Indies, Venezuela, Colombia, Bolivia, and Brazil (Yuncker 1932). In Brazil, this species is known from the North (Acre), Central-West (Goiás and Mato Grosso), Northeast (Bahia, Maranhão, Pernambuco, Piauí and Sergipe), and Southeast (Minas Gerais) regions. The species is found in semi-arid regions all year, especially in the summer months in the southern hemisphere.

Additional data. *Cuscuta partita* was observed parasitizing on plants from different families, such as *Evolvulus elegans* Moric. (Convolvulaceae) (CGMS 75470), *Chamaecrista nictitans* (L.) Moench (Fabaceae) (CGMS 75471), *Stylosanthes acuminata* M.B.Ferreira & Sousa Costa (Fabaceae) (CGMS 75472) and *Calea rupicola* Chodat (Asteraceae) (CGMS 75466).

Cuscuta platyloba Progel

Figure 2

New records. BRAZIL • 1 specimen; Mato Grosso do Sul, Campo Grande, Itatiaia Lake; 20°28′56″S, 054°34′31″W, 617 m a.s.l.; 5 Nov. 2018; fl. fr.; C. M. Costa leg. (CGMS 75475) • 1 specimen; same locality; 3 Jul. 2018; fl. fr.; C. M. Costa leg. (HAS 94419).

Identification. Flowers ca 2–4 mm long, white to cream; calyx as long as the corolla tube, lobes ovate to oblong, obtuse at apex, not overlapping; corolla campanulate, lobes ovate to oblong, obtuse at apex; infrastaminal scales shorter than the corolla tube, fringed with medium processes; capsule not circumscissile.

Geographic distribution. *Cuscuta platyloba* is distributed in Argentina, Uruguay, and Brazil (Múlgura 1979). In Brazil, it is found in the North (Pará), Central-West (Goiás and Mato Grosso), Southeast (Minas Gerais, Rio de Janeiro, and São Paulo) and South (Paraná, Rio Grande do Sul and Santa Catarina) regions.

Additional data. *Cuscuta platyloba* was observed parasitizing on two species at the same location. These were identified as *Machaerium acutifolium* Vog. (CGMS 75477) and *Duranta repens* L. (CGMS 75478).

Cuscuta xanthochortos var. *carinata* (Yunck.) Yunck.

Figure 2

New records. BRAZIL • 1 specimen; Mato Grosso do Sul, Campo Grande, Afonso Pena Avenue, 20°27′46″S, 054°36′36″W, 560 m a.s.l.; 19 Dec. 2018; fl. fr.; C.M. Costa leg. (CGMS 75475) • 1 specimen; same locality; 18 Dec. 2017; fl. fr.; C. M. Costa leg. (HAS 94418).

Identification. Flowers ca 3–4.5 mm long, white to cream; calyx as long as the corolla tube, lobes ovate, acute or obtuse at apex, carinate, overlapping; corolla campanulate, sometimes papillate, lobes ovate, obtuse at apex, carinate; infrastaminal scales shorter than the corolla tube, fringed with short processes; capsule circumscissile.

Geographic distribution. *Cuscuta xanthochortos* var. *carinata* occurs in Paraguay, Argentina, (Yuncker 1932)

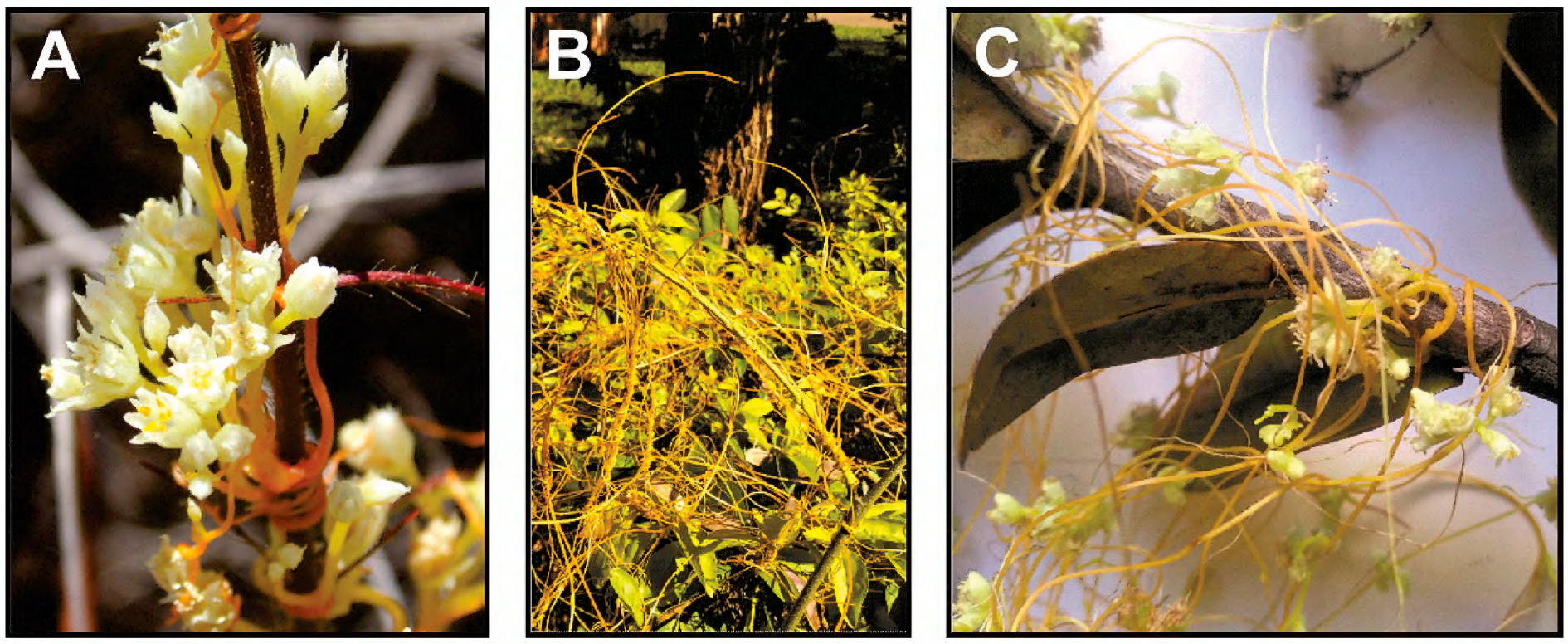

Figure 2. A. *Cuscuta partita*. **B.** *Cuscuta platyloba*. **C.** *Cuscuta xanthochortos* var. *carinata*.

and the Brazilian state of Santa Catarina (Flora do Brasil 2020).

Additional data. *Cuscuta xanthochortos* var. *carinata* was found in an urban garden, parasitizing on *Ixora coccinea* L. (Rubiaceae) (CGMS 75474).

Ecology of species. We collected the specimens of *C. partita* from rocky Cerrado at ca 370 m altitude in Furnas dos Baianos, which is part of the district of Piraputanga and belongs to the city Aquidauana (Mato Grosso do Sul, Brazil). Aquidauana city is located in a transition area between the plateau and Pantanal plain, and includes different types of vegetation such as forests, savanna, grassland, flooding areas, and rocky Cerrado. The vegetation in Furnas dos Baianos is characterized by rocky outcrops mainly composed of herbs and shrubs often smaller than 4 m high (Ribeiro and Walter 2008). The plants distributed in these areas are exposed to high solar incidence. The climate is characterized by a marked seasonality with a dry season (May to September) and a rainy season (October to April), being classified as Aw type, according to Köppen classification (Alvares et al. 2013). The average annual temperature is about 24.2 °C, but temperatures of 37 °C are often recorded during summer (rainy season). Precipitation reaches about 1400 mm per year (Climate-Data 2020).

C. platyloba and *C. xanthochortos* were found parasitizing ornamental plants and collected in the downtown of Campo Grande city, which is located near the borders of Paraguay and Bolivia, and is classified as Aw type according to Köppen classification (Alvares et al. 2013).

Discussion

Although Mato Grosso do Sul is among the Brazilian states with the fewest collected samples of plants (Shepherd 2003; Alves et al. 2018), and in the past few years, numerous projects and initiatives have been implemented to increase the collection effort in the state (Farinaccio et al. 2018). The lack of knowledge about several botanical groups in Mato Grosso do Sul is connected to the historical deficit of taxonomists working in the state. Very few botanists have been responsible for most floristic collections (Alves et al. 2018; Sartori and Pott 2018; Gasper et al. 2020).

As only *C. racemosa* had previously been reported from Mato Grosso do Sul, our new records increase the number of *Cuscuta* species to four in the state. These results show the importance of funding collections and botanical identifications to understand the true biodiversity of a region.

Parasitism by *C. partita* has been reported in Caatinga plant communities, where it has drastically affected the development of vegetative and reproductive structures in *Zornia diphylla* (L.) Pers. (Fabaceae) (Cruz Neto et al. 2017). Our field research revealed four additional hosts. *Cuscuta partita* was found parasitizing native vegetation in islands of vegetation at the top of Furna dos Baianos, a hill. We found that this species can change the growth and reproductive output of its hosts and, thus, modulate host frequency and abundance in plant communities. This is consistent with the keystone role that has been reported for other *Cuscuta* species (Jeschke et al. 1997; Press and Phoenix 2005; Costea and Stefanovic 2009; Zhao et al. 2018).

Cuscuta xanthochortos occurs mainly in regions having a subtropical climate, and the new record of this species in the tropical Central-Western region of Brazil (which has a tropical climate) was found in an urban garden, where the species was likely introduced (Olszewski et al. 2020). The new record of *C. platyloba* suggests that this species probably occurs throughout the Brazilian territory; however, as with other *Cuscuta* species, there has been underreporting of occurrences. Compared to the other species that we report here, it is the only one in which the chemical profile has already been described (Bäumel et al. 1991; Löffler et al. 1995).

Although none of the three species have previously been reported as agricultural pests, their ability to parasitize hosts of different families, e.g. Fabaceae in the

Cerrado biome, should be carefully studied. This region is widely known for its extensive soybean (Fabaceae) crops (Marris 2005), and future economic problems may emerge in relation to dodder parasitism, as it is well known that *Cuscuta* infestation can severely affect crop yields worldwide (Lanini and Kogan 2005; Costea and Tardif 2006).

These new records expand the known distributions of three species of *Cuscuta* subg. *Grammica* in Brazil and South America. The new findings also suggest that *Cuscuta* has been undercollected and underreported in Brazil as elsewhere (e.g. Costea et al. 2015), which reinforce the need for more field studies, more collections, and accurate identification of specimens by specialists.

Identification key for the species of *Cuscuta* from Mato Grosso do Sul state, Brazil

1. Capsule circumscissile
   2. Flowers white to cream; calyx lobes ovate, acute or obtuse, carinate..... ***C. xanthochortos***
   2′. Flowers reddish; calyx lobes triangular, acute or acuminate, not carinate ..... ***C. partita***
1′. Capsule not circumscissile
   3. Flowers slightly papillate, calyx ½–¾ as long as the corolla tube ..... ***C. racemosa***
   3′. Flowers not papillate; calyx as long as the corolla tube ..... ***C. platyloba***

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Authors' Contributions

CMC, AGB, DBS, and FMA collected the specimens; FAM, PPAF, SSS, and SCN, identified the specimens; CMC, AGB, and FMA revised herbarium collections; CMC, AGB, SSS, DBS, and FMA wrote the manuscript; all authors revised the text.

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